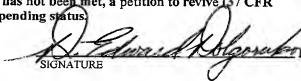


FORM PTO-1590 (REV. 11-2000)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER 1-15698	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371				U.S. APPLICATION NO. (If known, see 37 CFR 1.5 10/069860	
INTERNATIONAL APPLICATION NO. PCT/EP00/08282		INTERNATIONAL FILING DATE 24 August 2000 (24.08.2000)		PRIORITY DATE CLAIMED 28 August 1999 (28.08.1999)	
TITLE OF INVENTION SYSTEM FOR INSPECTING MATT, FLAT AND/OR SLIGHTLY CURVED SURFACES					
APPLICANT(S) FOR DO/EO/US ACHIM WILLING					
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:					
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.					
2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.					
3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.					
4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).					
5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2))					
a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).					
b. <input checked="" type="checkbox"/> has been communicated by the International Bureau.					
c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).					
6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).					
a. <input checked="" type="checkbox"/> is attached hereto.					
b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4).					
7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))					
a. <input checked="" type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).					
b. <input type="checkbox"/> have been communicated by the International Bureau.					
c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.					
d. <input type="checkbox"/> have not been made and will not be made.					
8. <input checked="" type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).					
9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).					
10. <input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).					
Items 11 to 20 below concern document(s) or information included:					
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.; Form SB/08A; prior art copies.					
12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.					
13. <input checked="" type="checkbox"/> A FIRST preliminary amendment.					
14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment.					
15. <input type="checkbox"/> A substitute specification.					
16. <input type="checkbox"/> A change of power of attorney and/or address letter.					
17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.					
18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4).					
19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).					
20. <input checked="" type="checkbox"/> Other items or information: Express mail certificate; return card; formal drawings (two sheets); a copy of the International Search Report; IP EA/409-w/English translation of amended claim(Exam Report); English trans. of ISA/210; Written Opinion IPEA/408; IB/304 Priority doc Transmittal; IB/308 In'tl Appln Trans.; Verification of Translation.					

U.S. APPLICATION NO. 10/069860 INTERNATIONAL APPLICATION NO. PCT/EP00/08282		ATTORNEY'S DOCKET NUMBER 1-15698																																														
21. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$1040 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$890 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$740 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$710 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100 ENTER APPROPRIATE BASIC FEE AMOUNT =		CALCULATIONS PTO USE ONLY <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">ENTER APPROPRIATE BASIC FEE AMOUNT =</td> <td style="width: 20%; text-align: right;">\$ 890.00</td> <td style="width: 20%;"></td> </tr> <tr> <td>Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)). <input type="checkbox"/> 20 <input type="checkbox"/> 30</td> <td style="text-align: right;">\$ -</td> <td></td> </tr> <tr> <td>CLAIMS</td> <td style="text-align: right;">NUMBER FILED</td> <td style="text-align: right;">NUMBER EXTRA</td> </tr> <tr> <td>Total claims</td> <td style="text-align: right;">16 - 20 =</td> <td style="text-align: right;">0</td> </tr> <tr> <td>Independent claims</td> <td style="text-align: right;">1 - 3 =</td> <td style="text-align: right;">0</td> </tr> <tr> <td>MULTIPLE DEPENDENT CLAIM(S) (if applicable)</td> <td></td> <td style="text-align: right;">+ 280.00</td> </tr> <tr> <td>TOTAL OF ABOVE CALCULATIONS =</td> <td style="text-align: right;">\$ 890.00</td> <td></td> </tr> <tr> <td><input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.</td> <td style="text-align: right;">\$ 445.00</td> <td></td> </tr> <tr> <td>SUBTOTAL =</td> <td style="text-align: right;">\$ 445.00</td> <td></td> </tr> <tr> <td>Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492(f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30</td> <td style="text-align: right;">\$ -</td> <td></td> </tr> <tr> <td>TOTAL NATIONAL FEE =</td> <td style="text-align: right;">\$ 445.00</td> <td></td> </tr> <tr> <td>Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +</td> <td style="text-align: right;">\$ -</td> <td></td> </tr> <tr> <td>TOTAL FEES ENCLOSED =</td> <td style="text-align: right;">\$ 445.00</td> <td></td> </tr> <tr> <td></td> <td style="text-align: right;">Amount to be refunded:</td> <td style="text-align: right;">\$</td> </tr> <tr> <td></td> <td style="text-align: right;">charged:</td> <td style="text-align: right;">\$</td> </tr> </table>		ENTER APPROPRIATE BASIC FEE AMOUNT =	\$ 890.00		Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)). <input type="checkbox"/> 20 <input type="checkbox"/> 30	\$ -		CLAIMS	NUMBER FILED	NUMBER EXTRA	Total claims	16 - 20 =	0	Independent claims	1 - 3 =	0	MULTIPLE DEPENDENT CLAIM(S) (if applicable)		+ 280.00	TOTAL OF ABOVE CALCULATIONS =	\$ 890.00		<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.	\$ 445.00		SUBTOTAL =	\$ 445.00		Processing fee of \$130.00 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492(f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30	\$ -		TOTAL NATIONAL FEE =	\$ 445.00		Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +	\$ -		TOTAL FEES ENCLOSED =	\$ 445.00			Amount to be refunded:	\$		charged:	\$
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a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>445.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>13-1816</u> . A duplicate copy of this sheet is enclosed. d. <input type="checkbox"/> Fees are to be charged to a credit card. WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.																																																
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.																																																
SEND ALL CORRESPONDENCE TO: MARSHALL & MELHORN, LLC D. Edward Dolgorukov Four SeaGate - 8th Floor Toledo, Ohio 43604 Phone: (419) 249-7146 Fax: (419) 249-7151 February 27, 2002		<div style="text-align: center;">  SIGNATURE </div> <div style="text-align: center;"> D. Edward Dolgorukov NAME <u>26,266</u> REGISTRATION NUMBER </div>																																														

Certificate under 37 CFR 1.10 of Mailing by "Express Mail"

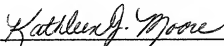
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Kathleen J. Moore

Typed or printed name of person mailing correspondence

Note: Each paper must have its own certificate of mailing by "Express Mail".

FILING UNDER 35 USC 371 IN THE UNITED STATES DESIGNATED/
ELECTED OFFICE

Int'l Appln. No.: PCT/EP00/08282

Int'l Filing Date: 24 August 2000

Priority Date Claimed: 28 August 1999

Title: System for Inspecting Matt, Flat and/or Slightly
Curved Surfaces

Applicant: Achim Willing

Attorneys: Marshall & Melhorn, LLC

Docket No.: 1-15698

10/069860

1013 R004701710 27 FEB 2002

VERIFICATION OF TRANSLATION

RE: INTERNATIONAL PATENT APPLICATION NO. PCT/EP00/08282,
filed on August 24th, 2000 and
published as WO 01/16584 on March 8th, 2001
"Anordnung zur Inspektion von matten ebenen und/oder
leicht gekrümmten"

I, Helen Ritchie Muir, M.A., of 1 Babbington Gardens, Dumfries
DG2 9JB, Scotland, am the translator of the original
application text of the above-referenced patent application
and of the amended claim 1 of same, and I state that the
following is a true translation to the best of my knowledge
and belief.

Signature of translator:

Helen R. Muir

Dated:

February 6th 2002

10069860-051002-2002

I hereby certify that this correspondence is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on February 27, 2002 and is addressed to the Commissioner for Patents, Box PCT, Washington, D.C. 20231.

Kathleen J. Moore

(Typed name of person mailing correspondence)

In re Application of:]	
ACHIM WILLING]	Group Art Unit:
]	
Serial No.]	
]	
Filing Under 35 U.S.C. 371 in the DO/EO/US]	Examiner:
off PCT/EP00/08282 filed 24 August 2000]	
]	
For: SYSTEM FOR INSPECTING MATT,]	Attorney Docket 1-15698
FLAT AND/OR SLIGHTLY]	
CURVED SURFACES]	

February 27, 2002

Commissioner for Patents
Box PCT
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Honorable Sir:

Prior to the first Office Action and before examination, please amend the application being filed concurrently herewith under 35 U.S.C. 371 as follows:

In the Specification:

Page 1, above line 1, insert --TITLE--; line 3, insert --BACKGROUND OF THE INVENTION--; between lines 3 and 4, insert --1. Field of the Invention--; line 9, insert --2. Discussion of Related Art--;

Page 2, line 8, insert --OBJECT OF THE INVENTION--; line 24, insert --BRIEF SUMMARY OF THE INVENTION--.

Page 4, line 32, insert --BRIEF DESCRIPTION OF THE DRAWINGS--.

Page 5, line 19, insert --DESCRIPTION OF THE PREFERRED EMBODIMENT--.

In the Claims:

Please delete original claims 1-16 and insert the following new claims (17-32):

17. (Newly presented) A system for inspecting matt, flat and/or slightly curved surfaces in order to identify defects which are associated with a modification of the course of the surface, in particular for examining matt unlacquered shell bodywork, in which system an illumination device irradiates the surface to be inspected at flat angles, said device having the following combined features:

the illumination device is formed from a plurality of elongated luminous surfaces which are disposed substantially parallel to one another, the angle between the normal line of an inspected surface element on the surface and the connecting line between the inspected surface element and a point on one of the elongated luminous surfaces is greater than approximately 60° ,

the light distribution of the respective elongated luminous surfaces is tightly concentrated in planes which lie transversely with respect to the longitudinal direction of the respective surface, with an aperture angle which is smaller than 15° , in such a way that a substantially sheet-type light distribution is produced which covers the surface portion to be inspected, and the observer is located within or at least in the proximity of the angle predetermined by reflection of the light radiated by the at least one elongated luminous surface on the surface portion to be inspected.

18. (Newly presented) A system according to claim 17, wherein the aperture angle of the sheet-type light distribution is smaller than 5° , preferably smaller than 2° .

19. (Newly presented) A system according to claim 17, wherein the angle between the normal line of an inspected surface element and the incident light ray of the elongated luminous surface is greater than 75° .

20. (Newly presented) A system according to claim 17, wherein the longitudinal direction of the luminous surfaces is substantially parallel to the longitudinal direction of the surface to be inspected which is illuminated by this luminous surface.

21. (Newly presented) A system according to claim 17, wherein each surface portion to be inspected is illuminated by at least one elongated luminous surface from its entire length and breadth.

22. (Newly presented) A system according to claim 17, wherein the luminous elongated surfaces so disposed beside one another are so arranged in respect of their concentration that they illuminate adjacent surfaces to be inspected in the same alignment.

23. (Newly presented) A system according to claim 17, wherein the illumination device has a light-radiating original surface which has a substantially uniform luminance distribution and wherein there is arranged in front of this original surface a plurality of lamellae which are substantially parallel to one another and which determine the desired aperture angle on the basis of their geometry.

24. (Newly presented) An illumination device according to claim 23, wherein the surfaces of the lamellae have a high reflection factor of the directed reflection at flat light entrance angles, and at steep light entrance angles reflect predominantly in a diffuse manner.

25. (Newly presented) A system according to claim 23, wherein the surface of the lamellae is black.

26. (Newly presented) A system according to claim 23, wherein the gaps between the lamellae are filled with a light-guiding transparent medium, and in that the surface of the lamellae is connected to the medium in an optically dense manner at least on one side.

27. (Newly presented) A system according to claim 12, wherein the observer is a person, a camera or some other sensor arrangement for capturing an image.

28. (Newly presented) A system according to claim 17, wherein the illumination device has a light-radiating original surface which has a substantially uniform luminance distribution the light-radiating original surface radiating at a solid angle which is greater than the solid angle of the radiation of the luminous surfaces.

29. (Newly presented) A system according to claim 17, wherein the illumination device has at least one elongated light source, the light distribution of which radiates widely in planes parallel to its axis.

30. (Newly presented) A system according to claim 17, wherein the illumination device has a light-radiating original surface which has a substantially uniform luminance distribution whereby the original surface is composed of a plurality of widely radiating, elongated light sources which are disposed beside one another, at least one pair of lamellae being placed in front of each light source.

31. (Newly presented) A system according to claim 17, wherein the illumination device has a light-radiating original surface which has a substantially uniform luminance distribution the original surface being formed from at least one elongated light source with a trough-like reflector.

32. (Newly presented) A system according to claim 17, wherein the position of the observer can be altered by optical measures such as mirrors, retro-reflective materials or prisms.

In the Abstract:

Page 13, line 34, delete "(Fig. 1)".

REMARKS

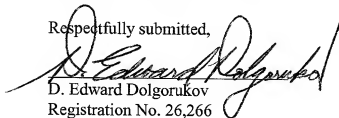
Applicants have amended the application to eliminate multiple dependencies from the claims and to adapt the specification, claims and abstract to U.S. patent practice.

As the changes to the specification are merely the insertion of subject headings, it is respectfully submitted that a separate marked-up copy is not required for the specification amendments.

Original claims 1-16 have been deleted. New claims 17-32 have been added. As no claims have been amended, it is respectfully submitted that a separate marked-up copy is not required. Claims 17-32 are currently pending in the subject application. No new matter has been added by any of these amendments.

Favorable consideration of the application as amended is respectfully requested.

Respectfully submitted,



D. Edward Dolgorukov
Registration No. 26,266

ATTORNEYS

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2/pvt

System for inspecting matt, flat and/or slightly curved surfaces

- 5 The invention relates to a system for inspecting matt, flat and/or slightly curved surfaces in order to identify defects which are associated with a modification of the course of the surface, especially for checking flat/unlacquered shell bodywork.
- 10 Systems for inspecting matt, flat and/or curved surfaces in order to identify surfaces are known, which have surfaces radiating strip-shaped light, by means of which surfaces unlacquered metal and plastics material surfaces are sampled for topographical defects in a
- 15 direction parallel with the surface. This requires incident light radiation at very flat radiation angles of approximately 5 to 10°, because at these angles the surfaces reflect in a very directed manner, whilst at steeper angles they predominantly reflect in a diffuse
- 20 manner. Such illumination strips are suitable only for small surface portions, or means have to be provided with which the strips can be moved relative to the surface (WO 98/15815). If, however, a plurality of strips are lined up beside one another to illuminate
- 25 larger surfaces, surface portions of the surface to be sampled which are located closer to the lights are illuminated at undesirably steep angles. This leads to

masking of defects and identifiable colours and colour effects which would normally be recognisable when associated with the luminous strip. Furthermore the problem of direct dazzling occurs since the lights do not only radiate in the desired directions onto the surface as a result of their light distribution which is too wide.

The object underlying the invention, therefore, is to create a system for inspecting matt, flat and/or slightly curved surfaces which always creates the same illumination conditions over a surface of any size to be sampled, the light distribution of the illumination being intended to be suitable for making topographical defects of an otherwise continuous surface clearly recognisable, the light radiation being intended to be limited to the solid angle required to illuminate the surface, in order to avoid dazzling when the light-radiating surface is viewed directly. At the same time, the luminous device used should be simple in its structure.

This object is accomplished according to the invention by the features of the main claim.

According to the invention the illumination device comprises a plurality of elongated luminous surfaces, disposed substantially parallel to one another and possessing substantially all the same light distribution, which is tightly concentrated in planes which lie transversely with respect to the longitudinal direction of the surfaces, with an aperture angle which is smaller than 15° , preferably 5° , and by even greater preference smaller than 2° , such that a substantially sheet-form light distribution is produced which covers the surface element to be inspected on the surface. In planes in the longitudinal direction of the surfaces, the illumination device has in each case a widely

radiating light distribution. The illumination device is so disposed that the angle between the normal line of the inspected surface element and the connecting line between the inspected surface element and any point on the elongated luminous surface is greater than roughly 60°, preferably however 75°, and the observer, i.e. a person or a camera or the like, is located within or at least in the proximity of the at least one elongated strip illuminating by reflection of the sheet-type light distribution on the surface portion to be inspected. By means of this system, illumination is achieved which does not cause any inadvertent dazzling when the light-radiating surfaces are viewed directly, and which permits good detectability of defects which are connected with a modification of the course of the surface.

With the same illumination principle, the position of the observer can be altered by optical means such as mirrors, retro-reflective foils or prisms.

Through the measures quoted in the subordinate claims, advantageous developments and improvements are possible.

Preferably the illumination device used has a light-radiating original surface, in front of which a bundle with parallel lamellae surfaces is disposed, the main radiation direction of the original surface radiating light through the lamellae arrangement. The original surface has uniform luminance distribution and radiates light in a larger solid angle area than the totality of the elongated light-radiating surfaces at the end of the lamellae bundle. The lamellae arrangement is preferably so dimensioned in respect of its geometry, i.e. spacing and depth, that diagonally to the lamellae surface the aperture angle is smaller than 15°,

preferably smaller than 5° , and by particular preference smaller than 2° .

- The original surface is preferably formed by elongated light sources lying beside one another or also by at least one elongated light source which is surrounded by a trough-like reflector. The elongated lamps can be for example fluorescent lamps or linear incandescent lamps, the light distribution of which is automatically widespread in planes parallel to the lamp axis. It is propitious to use only a few lamps and so to align their light distribution by reflectors or lenses that the solid angle region over which the radiation falls is greater than the solid angle required by the entire illumination device.
- According to the invention, the surfaces of the lamellae scatter light in a diffuse manner with a smaller proportion of directed reflection, or they reflect in a directed manner with a small reflection factor. A gap-free illumination in a narrow angle range is produced according to the invention with surfaces which at very flat incident light angles have a high degree of directed reflection and at steeper incident light angles pass into diffuse reflection. These are, for example, lacquered surfaces or metallic surfaces. The surfaces of the lamellae are preferably black or grey.

In a preferred embodiment, the lamellae can also be disposed either on one or on both sides of light guide plates so as to be optically dense, filling the gaps between the plates and having polished light entrance and exit surfaces.

Embodiments of the invention are represented in the drawing and are described in greater detail in the following description. The figures show:

Fig. 1: a schematic front elevation of the system according to the invention,

Fig. 2: a perspective view of an illumination device which is used in the system according to the invention,

Fig. 3: a section through a further embodiment of an illumination device, as is used in the system according to the invention,

Fig. 4: a representation of light distributions, as used in an illumination device according to the invention,

Fig. 5: the representation of a sheet-type light distribution according to Fig. 4,

Fig. 6: ray paths at the lamellae used in the illumination device according to the invention, and

Fig. 7: ray paths according to Fig. 6 at other angles of incidence.

In Fig. 1 is represented a system for inspecting the side surfaces of shell bodywork 1, in which system at least one illumination device 2 illuminates a flat or slightly curved surface 3, which is roughly perpendicular in the embodiment shown, and an observer 4 inspects the illuminated surfaces for defects which are connected with a modification of the course of the surface, i.e. topographical defects. The observer can here be a person; a camera or some other sensor arrangement for detecting the image of the surface can also be provided. Illumination by the illumination device 2 takes place at a flat angle smaller than 30° , and preferably smaller than 15° , i.e. greater than 60°

to the normal line of the surface 3, preferably greater than 75° . The observer 4 is located within or in the proximity of the angle predetermined by the reflection of the light rays of the illumination device 2, i.e. approximately in the mirror angle. The illumination device 2 is represented in various embodiments in Figs. 2 and 3, the light distribution of the illumination device being recognisable in Figs. 4 and 5. The illumination device 2 has a plurality of elongated luminous surfaces 5 lying beside one another, which together form the light exit surface 6 of the illumination system 2. The longitudinal direction of the luminous surfaces 5 is perpendicular in Fig. 1 to the page plane, and in an identical longitudinal direction, i.e. in a longitudinal direction parallel to the longitudinal direction of the luminous surfaces 5, lies the surface to be inspected 3. The light distribution of each luminous surface 5 is represented in Fig. 4 and Fig. 5, the light distribution 7 showing the radiation in planes which lie transversely with respect to the longitudinal direction of the luminous surface 5, whilst the light distribution 8 represents the widespread radiation in planes in the longitudinal direction of the luminous surface 5. One surface element 9 of the luminous surface 5 is represented in Fig. 5 in a small x-, y- and z-coordinate system, which delivers a light distribution according to Fig. 4. Here z represents the longitudinal direction and it can be recognised that the light is tightly concentrated in planes which lie transversely with respect to the longitudinal direction, such that a substantially sheet-type light distribution 10 is produced. Here the aperture angle in the planes which lie transversely with respect to the longitudinal direction is smaller than 15° ; an aperture angle of smaller than 5° is better, however preferably smaller than 2° .

The luminous surfaces 5, as shown in Fig. 1, have such a sheet-type light distribution 10, the light thus being radiated in narrow strips onto the surface 3. These narrow strips lie on the surface 3 transversely with respect to the longitudinal direction of the surface, and they preferably only overlap one another slightly. The strips are viewed by the observer 4 at an angle which deviates slightly from the mirror angle but is in the vicinity of same since in this case topographical details can be recognised even better.

In Fig. 2 is represented an illumination device 2, the luminous original surface 11 of which is formed from a plurality of lamps 12 aligned parallel to one another and at a small spacing from one another. The luminous original surface 11 has a uniform luminous distribution, the lamps being for example elongated fluorescent lamps or linear incandescent lamps. In front of the lamps is disposed a plurality of lamellae 13 aligned parallel and forming a lamellae bundle, which as a result of their geometry, i.e. their mutual spacing and their depth, form the desired aperture angle of smaller than 15° , better 5° , preferably 2° .

In Fig. 3 is represented a further embodiment of the illumination device used in Fig. 1, and this in section, an elongated light source 14 also being used here which is surrounded by a reflector which is configured trough-like for example. Here the inner side of the reflector 5 facing the lamp 14 forms the original surface, the luminance of which is uniformly distributed. In front of the reflector 5 is arranged again a bundle of lamellae 13, the aperture angle of a luminous surface corresponding to the light distribution according to Fig. 5 being given by the light rays 16. The illuminated surface is in this case interrupted again and again in oblique directions by the lamellae 13.

Fig. 6 shows a continuously illuminated light-radiating surface 6, formed from two partial surfaces, between the lamellae 13, of which only three are shown here. This uniform light-radiating surface 6 is produced by directed reflection of the light rays 17, 18 at the lamellae 13 at flat angles, such that the surface to be inspected is also illuminated without any gaps.

In Fig. 7, on the other hand, steeper light rays 19, 20 are represented, from the direction of which the lamellae optical system now appears dark. Rays 19 and 20 are produced by multiple reflections of rays 21 and 22, which moreover impinge at steeper angles of light incidence, at which the degree of the directed reflection decreases, such that rays 19 and 20 have practically no luminance anymore. This means that the observer 4, if he inadvertently looks directly into the illumination device 2 according to Fig. 1, is not dazzled. The surfaces of the lamellae are preferably black.

In a further embodiment of the illumination device, for example according to Fig. 3, between the lamellae 13 are provided light-guiding transparent plates, i.e. the gaps between the lamellae 13 are filled with a light-guiding transparent medium, the lamellae surface being connected at least on one side in an optically dense manner to the transparent medium or respectively the light guide plates. Here the light guide plates have polished light entrance and exit surfaces.

The abstract forms part of the disclosure of the present invention, i.e. part of the description.

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Dr. Ing. Willing GmbH

Patent claims

1. System for inspecting matt, flat and/or slightly
5 curved surfaces in order to identify defects which are
associated with a modification of the course of the
surface, in particular for examining matt unlacquered
shell bodywork, in which system an illumination device
(2) irradiates the surface (3) to be inspected at flat
10 angles, said device having the following combined
features:
the illumination device (2) is formed from a plurality
of elongated luminous surfaces (5) which are disposed
substantially parallel to one another,
15 the angle between the normal line of an inspected
surface element on the surface and the connecting line
between the inspected surface element and a point on
one of the elongated luminous surfaces (5) is greater
than approximately 60° ,
20 the light distribution of the respective elongated
luminous surfaces is tightly concentrated in planes
which lie transversely with respect to the longitudinal
direction of the respective surface, with an aperture
angle which is smaller than 15° , in such a way that a
25 substantially sheet-type light distribution is produced
which covers the surface portion to be inspected, and
the observer (4) is located within or at least in the
proximity of the angle predetermined by reflection of
the light radiated by the at least one elongated
30 luminous surface on the surface portion to be
inspected.

2. System according to claim 1, **characterised in that**
the aperture angle of the sheet-type light distribution
is smaller than 5° , preferably smaller than 2° .

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3. System according to claim 1 or claim 2,
characterised in that the angle between the normal line
of an inspected surface element and the incident light
ray of the elongated luminous surface is greater than
5 75°.

4. System according to one of claims 1 to 3,
characterised in that the longitudinal direction of the
luminous surfaces (5) is substantially parallel to the
longitudinal direction of the surface (3) to be
10 inspected which is illuminated by this luminous
surface.

5. System according to one of claims 1 to 4,
characterised in that each surface portion to be
inspected is illuminated by at least one elongated
15 luminous surface (5) from its entire length and
breadth.

6. System according to one of claims 1 to 5,
characterised in that the luminous elongated surfaces
(5) so disposed beside one another are so arranged in
20 respect of their concentration that they illuminate
adjacent surfaces to be inspected in the same
alignment.

7. System according to one of claims 1 to 6,
characterised in that the illumination device (2) has a
25 light-radiating original surface (11, 15) which has a
substantially uniform luminance distribution and in
that there is arranged in front of this original
surface a plurality of lamellae (13) which are
substantially parallel to one another and which
30 determine the desired aperture angle on the basis of
their geometry.

8. Illumination device according to claim 7,
characterised in that the surfaces of the lamellae (13)

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have a high reflection factor of the directed reflection at flat light entrance angles, and at steep light entrance angles reflect predominantly in a diffuse manner.

- 5 9. System according to claim 7 or 8, **characterised in that** the surface of the lamellae (13) is black.

- 10 10. System according to one of claims 7 to 9, **characterised in that** the gaps between the lamellae (13) are filled with a light-guiding transparent medium, and in that the surface of the lamellae (13) is connected to the medium in an optically dense manner at least on one side.

- 15 11. System according to one of claims 1 to 10, **characterised in that** the observer is a person, a camera or some other sensor arrangement for capturing an image.

- 20 12. System according to one of claims 1 to 10, **characterised in that** the light-radiating original surface radiates at a solid angle which is greater than the solid angle of the radiation of the luminous surfaces (5).

- 25 13. System according to one of claims 1 to 12, **characterised in that** the illumination device has at least one elongated light source (12, 14), the light distribution of which radiates widely in planes parallel to its axis.

- 30 14. System according to one of claims 1 to 13, **characterised in that** the original surface (12) is composed of a plurality of widely radiating, elongated light sources which are disposed beside one another, at least one pair of lamellae (13) being placed in front of each light source.

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15. System according to one of claims 1 to 13, **characterised in that** the original surface is formed from at least one elongated light source (14) with a trough-like reflector (15).

- 5 16. System according to one claims 1 to 13, **characterised in that** the position of the observer can be altered by optical measures such as mirrors, retro-reflective materials or prisms.

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Abstract

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The invention relates to a system for inspecting matt, flat and/or slightly curved surfaces in order to identify defects which are associated with a modification of the course of the surface, in particular for inspecting matt, unlacquered shell bodywork. An illumination device is provided here which irradiates the surface to be inspected at flat angles. The illumination device consists of a plurality of elongated luminous surfaces which are arranged substantially parallel to one another, the longitudinal direction of the luminous surfaces being aligned substantially parallel to the longitudinal direction of the surface to be inspected. Each point of the luminous surface contributes to the illumination. The angle between the normal line of an inspected surface element on the surface and the connecting line between the inspected surface element and any point on one of the elongated luminous surfaces is always greater than approximately 70° . The light distribution of each elongated luminous surface is tightly concentrated in planes which lie transversely with respect to the longitudinal direction of the respective surface, with an aperture angle which is preferably smaller than 15° , better 5° , preferably smaller than 2° , in such a way that a substantially sheet-type light distribution is achieved, which covers the surface element to be inspected on the surface. The observer is located within or at least in the vicinity of the angle predetermined by reflection of the sheet-type light distribution of the at least one elongated luminous surface on the surface portion to be inspected.

(Fig. 1)

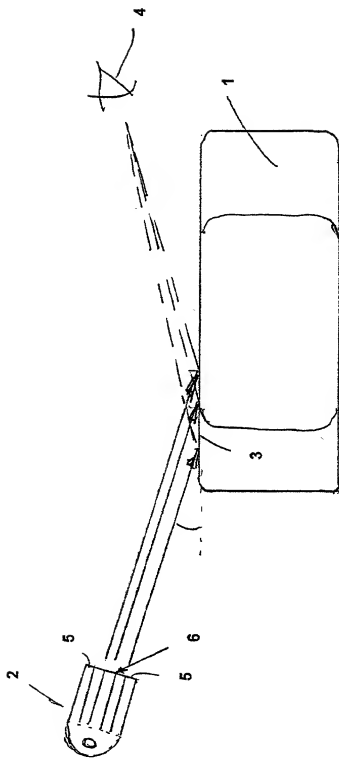


Fig. 1

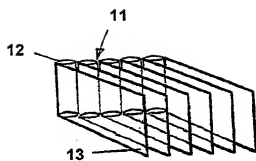


Fig. 2

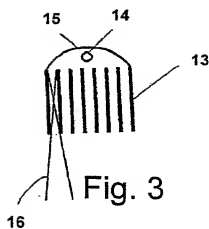


Fig. 3

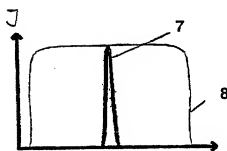


Fig. 4

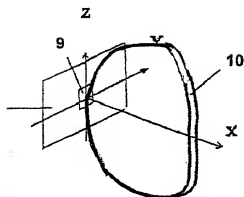


Fig. 5

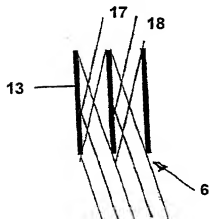


Fig. 6

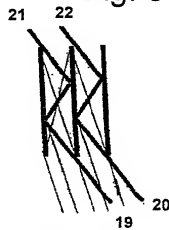


Fig. 7

COMBINED DECLARATION AND POWER OF ATTORNEY
IN ORIGINAL APPLICATION

ATTORNEY DOCKET
NO. 1-15698

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name,

I believe that I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled SYSTEM FOR INSPECTING MATT. FLAT AND/OR SLIGHTLY CURVED SURFACES

the specification of which

(check one) ☐ is attached hereto, and is a filing under 35 USC 371 of PCT International Application No. PCT/ / and was amended on .

☒ was filed on as U.S. Serial No. 10/069,860 under 35 USC 371 of PCT International Application No. PCT/EP00/08282, and was amended on February 27, 2002.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent; and

☐ if this is a continuation-in-part application, information that occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application, in accordance with 37 CFR 1.63(e); and

☒ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 CFR 1.98.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

199 41 028.3

(Number)

Germany

(Country)

28 August 1999 (28.08.1999)

(Day/Month/Year Filed)

Priority Claimed

XX

Yes

No

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Appln. Serial No.)(Filing Date)(Status) (patented, pending, abandoned)(Appln. Serial No.)(Filing Date)(Status) (patented, pending, abandoned)

If foreign agent is involved, the undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from Pfenning, Meinig & Partner (foreign agent) as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith with full power of substitution and revocation: D. Edward Dolgorukov, Reg. No. 26,266; Mark A. Hixon, Reg. No. 44,766; Donald A. Schurr, Reg. No. 34,247; Stephen P. Evans, Reg. No. 47,281; Phillip S. Oberlin, Reg. No. 19,066; and Angelica M. Colwell, Reg. No. 46,637, all of the law firm of Marshall & Melhorn, LLC, Four SeaGate - 8th Floor, Toledo, Ohio 43604. Address all telephone calls to D. Edward Dolgorukov at telephone number (419) 249-7146. Address all correspondence to MARSHALL & MELHORN, LLC, Four SeaGate - 8th Floor, Toledo, Ohio 43604, Attention: D. Edward Dolgorukov.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor ACHIM WILLING

Inventor's signature *Achim Willing* Date March 15, 2002

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Citizenship Germany Post Office Address Same as above

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